

Using a Glasstop Nuclear Power Plant Simulator for Control Room Modernization

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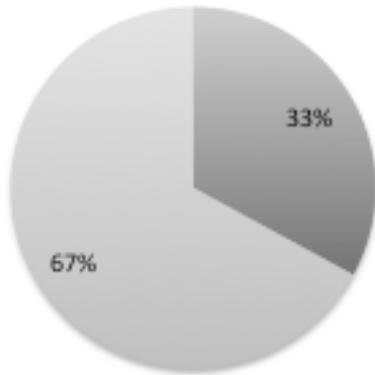
why is a national lab working on simulators?

DOE Light Water Reactor Sustainability (LWRS) Program

- Currently over 20% of nation's electricity is generated through nuclear power plants
- Original operating licenses were for 40 years
 - To ensure continued supply, license extensions up to 60 or 80 years
- None of ~100 current reactors in US has a fully upgraded main control room yet
 - Obsolete analog-only technology with some digital islands

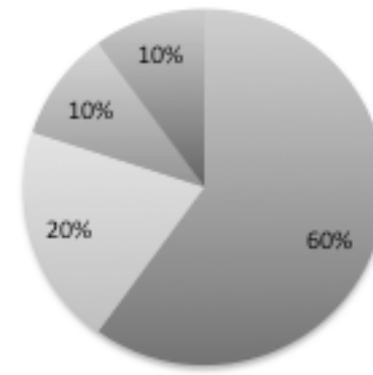
different control room upgrade paths

Preferred Upgrade Path



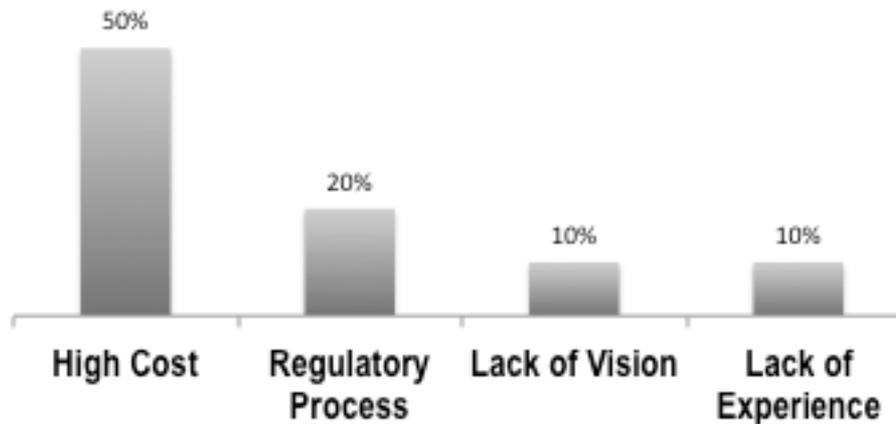
- Partially Modernized I&C and HSI
- Fully Modernized I&C and HSI

Likely Upgrade Path



- Partially Modernized I&C and HSI
- Fully Modernized I&C and HSI
- Modernized I&C Only
- Piecemeal

Upgrade Barriers



our vision

Help Utilities Complete Control Room Upgrades

- Work on **hybrid** control rooms, where digital is being added to analog boards
- Bridge utilities, researchers, regulator, and vendors

Getting There

- Develop and operate a research simulator that serves as utility user facility
- Validate digital design concepts
 - Prototype
 - Operator-in-the-loop testing (human factors)



a platform for control room research

Human System Simulation Laboratory



a reconfigurable,
full-scale,
full-scope
research simulator

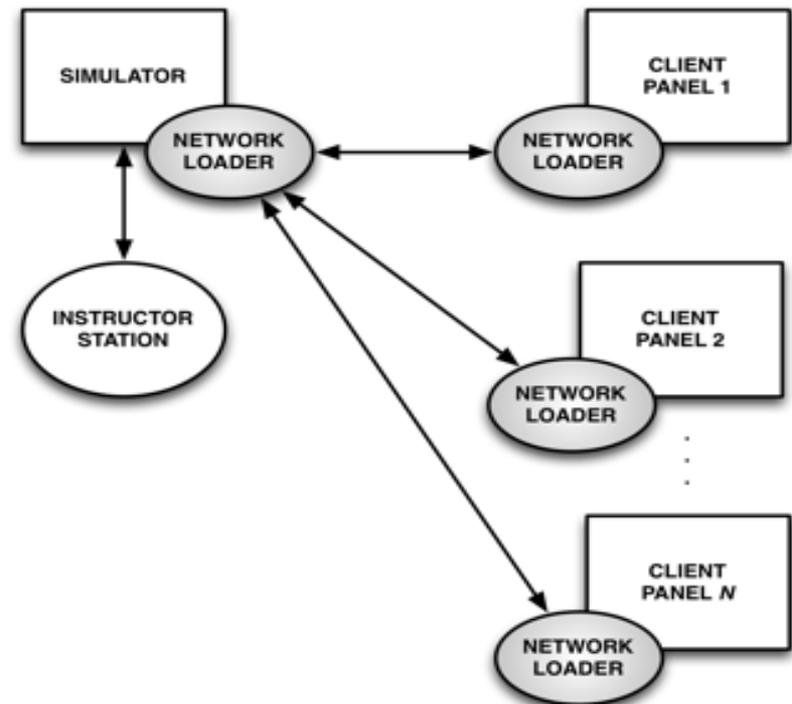
HSSL: a *reconfigurable*, full-scale, full-scope research simulator

15 L-3/MAPPS glasstop panels



Server-client software architecture from different simulator vendors

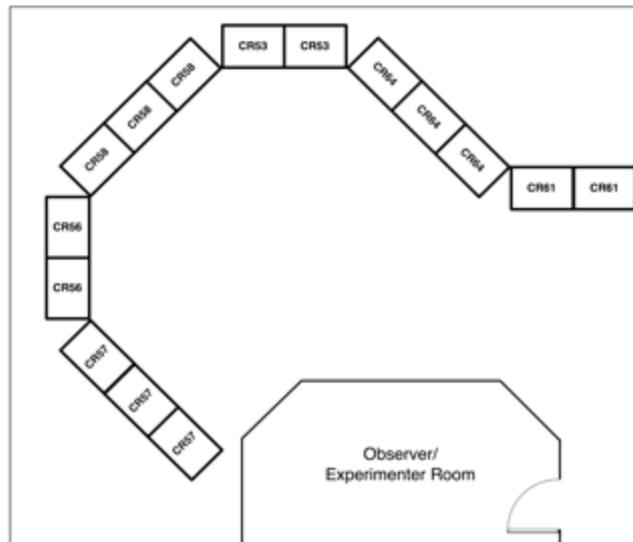
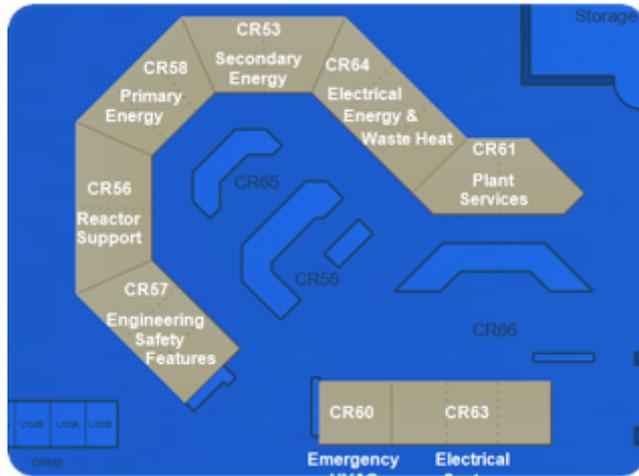
1. L-3/MAPPS
2. GSE
3. WSC
4. DCS vendors (e.g., Honeywell)



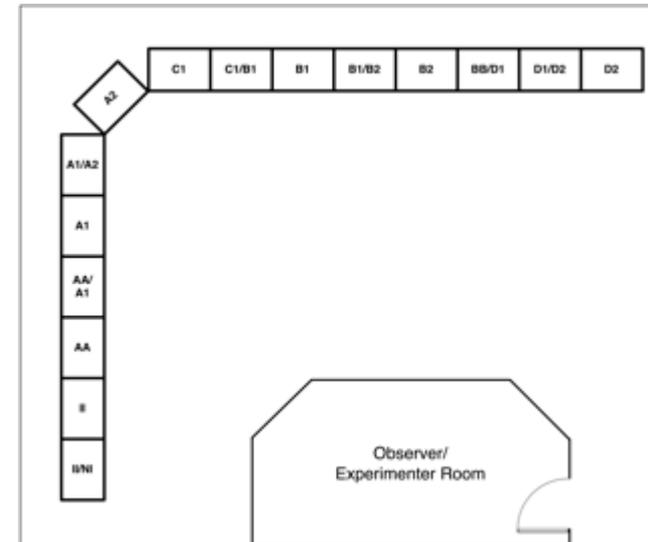
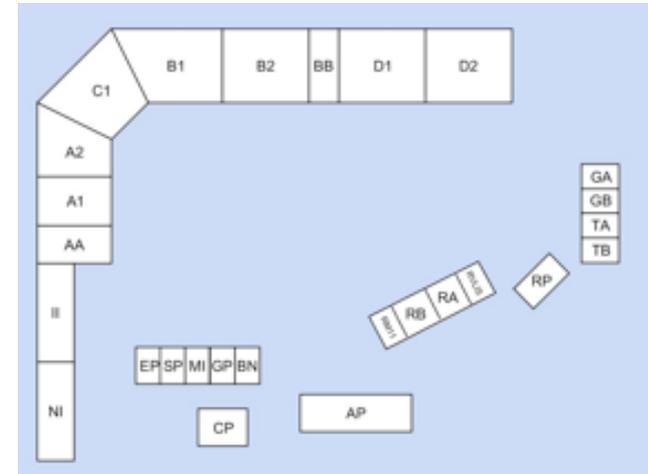
HSSL: a reconfigurable, *full-scale*, full-scope research simulator

15 panels allow mapping to full front panels of main control rooms

SONGS



Harris



HSSL: a reconfigurable, full-scale, *full-scope* research simulator

Plant Models (Training Simulators)

- **L-3/MAPPS:** SONGS, McGuire (planned)
- **GSE:** Shearon Harris, gPWR
- **WSC:** H.B. Robinson



HSSL: a reconfigurable, full-scale, full-scope *research simulator*

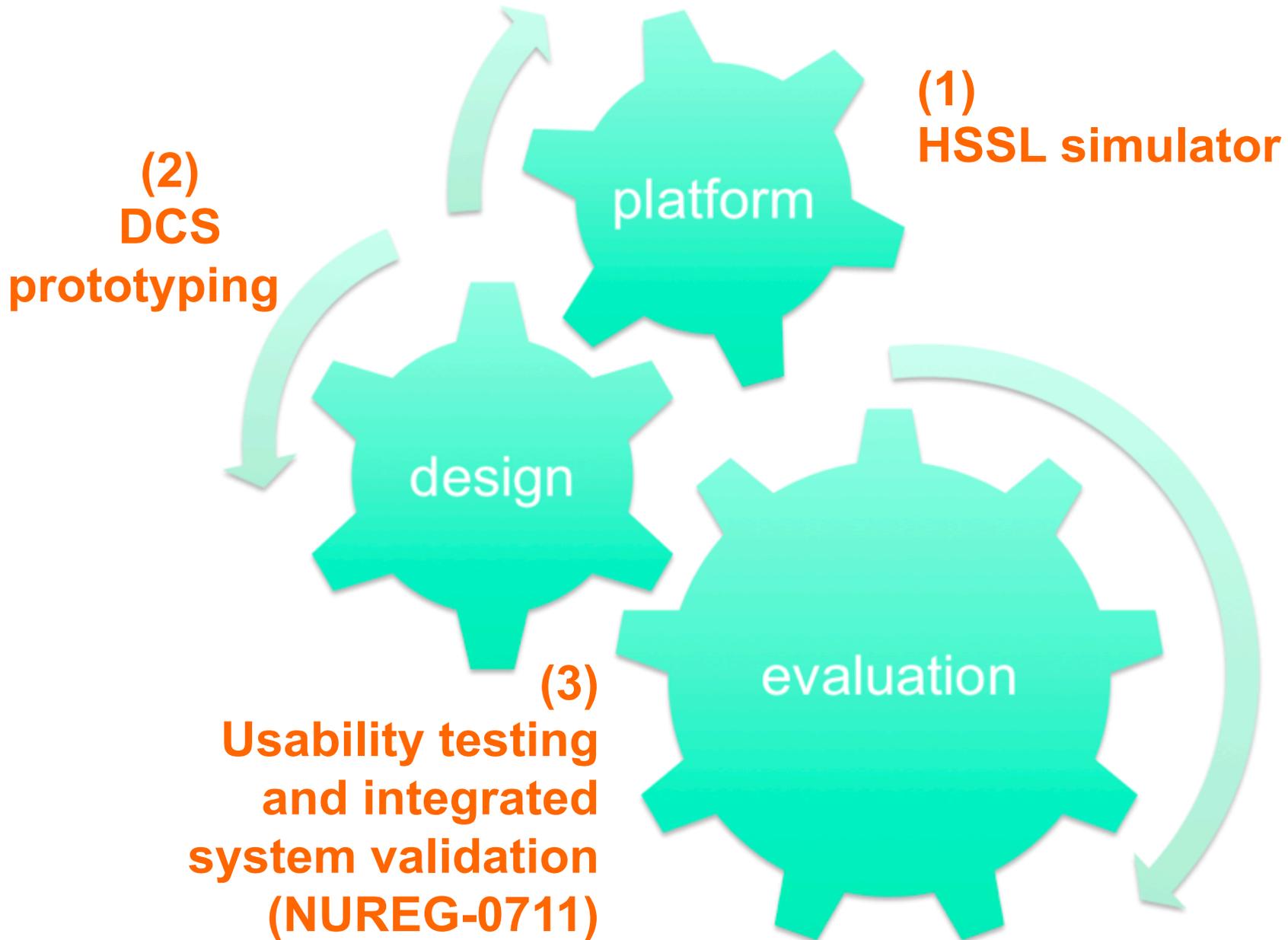


develop proof of concept prototypes and validate with operator-in-the-loop testing

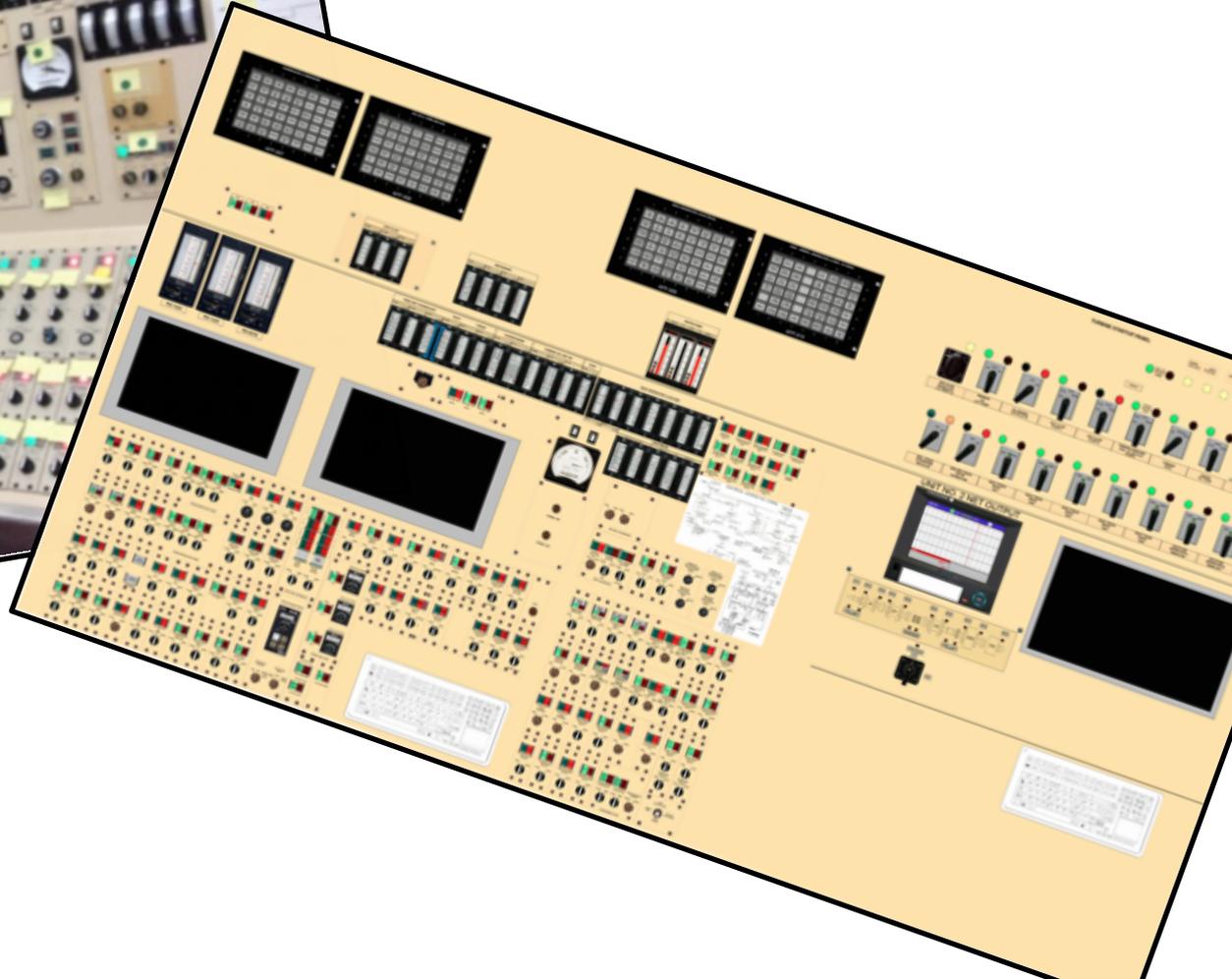


the design process

requirements for human factors



board layout: where do we put DCS?

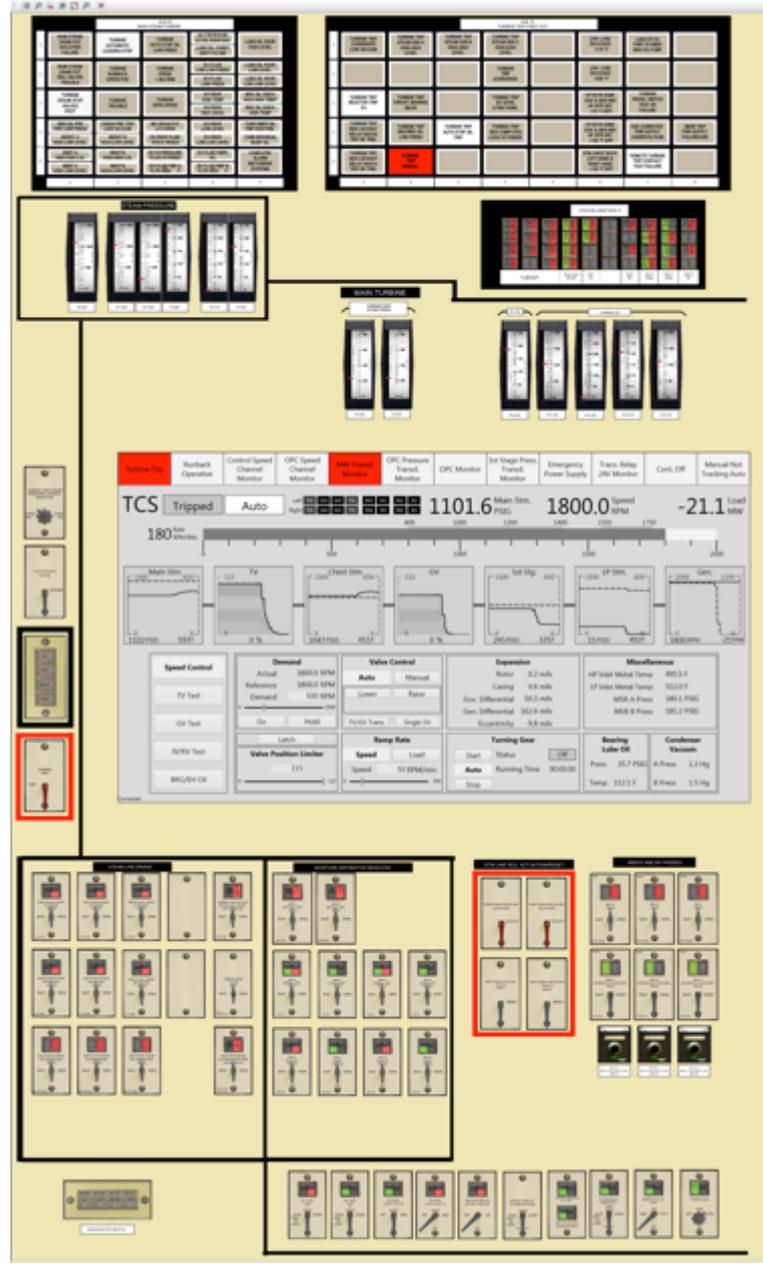
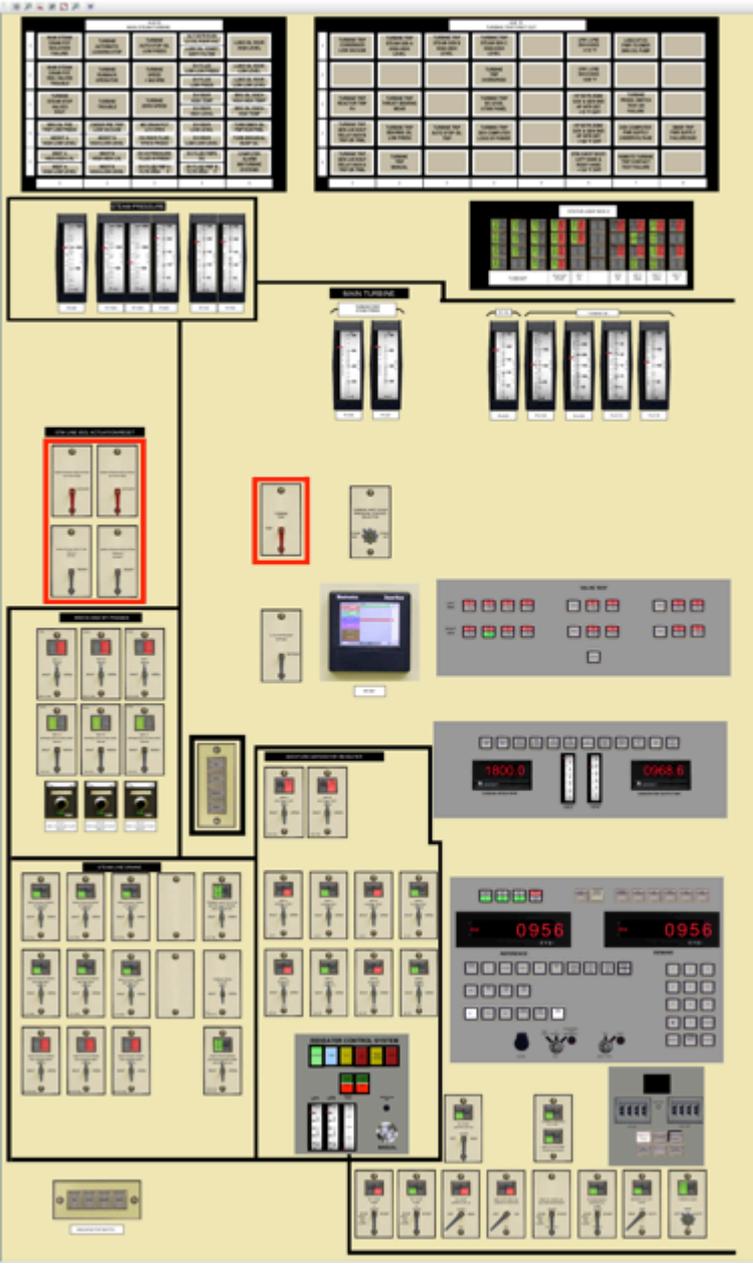


prototype: build it virtually in the HSSL

Turbine Control System

< Original

New >
(DCS PiP)



advanced concepts: COSS CVCS

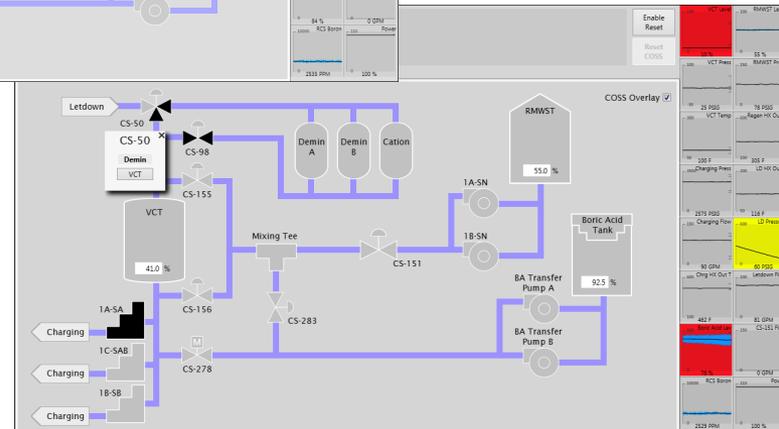
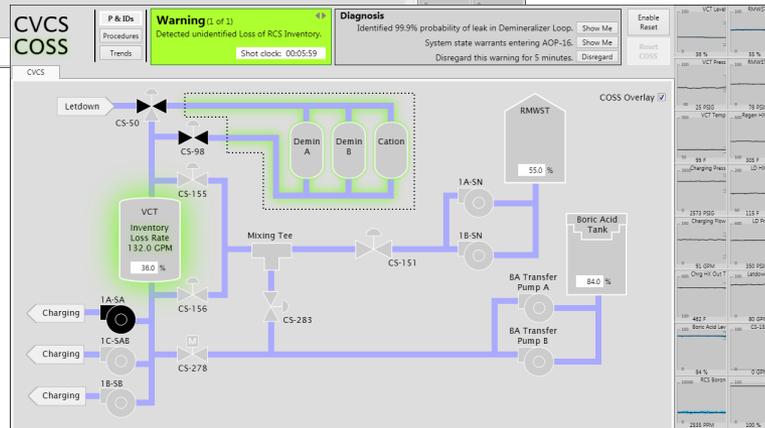
Develop First-of-a-Kind Computerized Operator Support System

computer
based
procedures

prognostic
recommender
system

advanced
alarm trend
displays

The screenshot displays the COSS CVCS interface for AOP-016 Excessive Primary Plant Leakage. It features a 'Warning (1 of 1)' banner with a green background, indicating a 'Detected unidentified Loss of RCS Inventory' with a 'Shot clock: 00:05:39'. A 'Diagnosis' section states a 99.9% probability of a leak in the Demineralizer Loop. The interface includes a 'Purpose' section (Leakage from outside of CNMT (CVCS)), 'Entry Conditions' (Unexplained loss of RCS inventory), and 'Operator Actions' (Check RHR in operation, Go To AOP-020 Loss of RCS Inventory Residual Heat Removal While Shutdown, Refer To PEP-110 Emergency). A 'Response Not Obtained' section is also visible.





what's next?

what we're doing in 2014

Move into a new, purpose built lab facility



Help develop fleetwide turbine control system upgrades for Duke Energy

- Robinson, Harris, Brunswick, and McGuire

Develop (and publish) guidance for operator performance metrics

- What's the best set of metrics to evaluate operator performance for upgrades?



**I/C TESTING
IN PROGRESS**